We think the main value of the work is its illustration of the worthlessness of exterior coloration in shells to the systematist, and the interest of this ornamentation problem as an independent question of physiology, or possibly of morphology.

F. N. BALCH.

Distribution and Variation. — In the *Procès Verbaux Soc. Roy. Malacol. de Belgique* meeting of February, 1898, is reported an interesting discussion on "L'Émigration considérée comme facteur de l'évolution et de filiation des espèces." It was *apropos* of a paper by M. Arnold Locard in the *Compt. Rend. l'Acad. Sci.*, No. 5, 1898, on the area of distribution of the molluscan fauna of the boreal Atlantic in the deeper waters to the south. Locard pointed out that recent explorations had shown that forms littoral or sublittoral in the boreal regions have spread southward, into ever-deepening waters, from an area approximately of common origin, down the European and African shores to the latitude of Guinea, in about 2000 fathoms, and down the American shores to the latitude of the Antilles, in about 800 fathoms. The area of distribution would thus have the form of a vast triangle of which the apex would rest in about 50 fathoms, somewhere north of Iceland, while the base connected the north-tropical shores of Africa and America, passing upward from east to west from a depth of 2000 fathoms to one of 800. M. Locard's idea, M. Van den Broek thought, was that migration occurs, speaking largely, in opposition to variation. That is, a northern species under pressure from a changing environment or from crowding might spread along the coast where bathymetric and other conditions would be little changed, but the temperature change would be great, or it might spread downward where the changes would be just the opposite. In either case it would follow the line of least resistance; *i.e.*, that in which the required variation would be least. Emigration would replace adaptation and prove a factor of stability.

From this idea M. Van den Broek differs. He points out that while deeper water was doubtless the line of least resistance in migration, and probably called for less variation than migration along the coast would have done (as is indicated, moreover, by the archaic facies of abyssal life), yet the *cause* of migration is uncertain. It may be to escape the competition of more competent rivals, or local enemies, or parasites, or it may be in the wake of a migrating food supply, and in such cases might not be along the line calling for least variation. In the case of the deep-water and arctic Mollusca it

certainly appears that temperature was the main factor, and probably it was true that changes in bathymetric conditions called for less variation than changes of temperature conditions would have done; but, even so, migration proves ultimately a great source of variation. The gradual nature of changes on the sea-bottom leads to very extended distribution, and consequently into areas which are changing in very opposite ways; *e.g.*, sinking and rising. With such wide geographical distribution come extreme differences, eventually, in food and other variation factors. Oscillation of the bottom, M. Van den Broek thinks, would be particularly effective in breaking up the widely dispersed species, and he points out that a species changed by a shoaling of the water would not revert to its old form upon the waters again deepening, but would undergo a second change, removing it yet a step from the ancestral form which lived under similar conditions. M. Van den Broek believes widespread movements like the one under discussion have taken place repeatedly, and that the ancestors of a given fauna are to be looked for, not in the underlying strata, but in distant formations representing the same essentials of environment. Thus he finds the ancestral forms of the Belgian Miocene sands, not in the underlying Oligocene clays, but in the older Miocene of North Germany, while the descendants of the Belgian Miocene sands he identifies, tracing a northeast to southwest migration, accompanied by an increasing salinity and depth, but constant temperature, in the fauna of the Coralline Crag of Suffolk; while above this point, in the Red Crag, he sees the extinction or profound modification of the forms and an invasion of new boreal forms, indicating a great increase of depth by sinking.

This discussion is suggestive, but it seems clear that M. Van den Broek has not settled the question. If his species migrated into deep water because it was the line of least resistance in the first place, why did they not do so again when the bottom rose? Again, is it not true that no matter what the cause of migration may be, that method is chosen because it is the one calling for least modification? We will suppose that a migration along the shore calls for greater modification than migration into deeper water, and that the original habitat is unchanging, but that competition is too great or depredation too fierce. It seems that the greatest amount of modification would be needed before the competition would be successfully met or the depredation resisted. If less were required for this than for the change of habitat, the difficulty would be thus met.

The consideration of migration as a factor of stability is of some

interest, and certainly the deep-sea fauna is an excellent subject for such speculations, because, as Mr. Dall has so interestingly pointed out, the struggle for life on the sea-bottom must in great depths be reduced to a minimum, from the vast area at the disposal of any species, the practically unlimited supply of food, such as it is, the fewness of predatory forms, and the rarity of the sudden vicissitudes of land and littoral life; so that such modifications as do take place must be comparatively direct results of the physical environment.

F. N. BALCH.

Zoölogical Results of Dr. Willey's Expedition. Part II.[1] — The second part of the zoölogical results of Dr. Willey's expedition to the Western Pacific comprises reports on the genus Millepora by Dr. Sydney J. Hickson, Echinoderms by F. Jeffrey Bell, Holothurians by F. P. Bedford, Sipunculoidæ by A. E. Shipley, Solitary Corals and Postembryonic Development of Cycloseris by J. Stanley Gardiner, Earthworms by F. E. Beddard, and Gorgonacea by Isa L. Hiles.

Dr. Hickson ascribes all of the specimens of Millepora to *M. alicornis*, which, he has before pointed out, is the only species of Millepora so far known. The parts of Dr. Hickson's paper that are particularly interesting are those that are devoted to the parasites of this coral. In addition to worms and algæ, he speaks of "spots scattered over the surface of the coral having the general appearance of a rash." He concludes "that these bodies are clusters or zoögloeæ of parasitic bacteria." Of the thirty-nine species of Echinoderms of Professor Bell's Report, two of which are possibly new, six belong to the Crinoids, twelve to the Echinoids, fourteen to the Asteroids, and seven to the Ophiurioids. Two new species of Holothurians are described by Mr. Bedford among the twenty-four in the collection. Mr. Bedford calls attention to some interesting variations in two species, in the number of stone canals, polian vesicles, and cuverian organs. Mr. Shipley's account of the Sipunculoidea enumerates twenty-three species, none of which are new. Probably the most important contributions to systematic zoölogy in the series are the papers of Mr. Gardiner and Miss Hiles, and Mr. Beddard's report on the earthworms. Mr. Gardiner describes eleven new species of solitary corals among fourteen, and Miss Hiles four new forms of

[1] Willey, Arthur, D.Sc., etc. *Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands, and Elsewhere*, collected during the years 1895, 1896, and 1897. Part II. Cambridge, the University Press (1899), pp. 121–206, Pls. XII–XXIII.